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Abrasion and Fracture Testing in a High-Pressure Hydrogen Environment

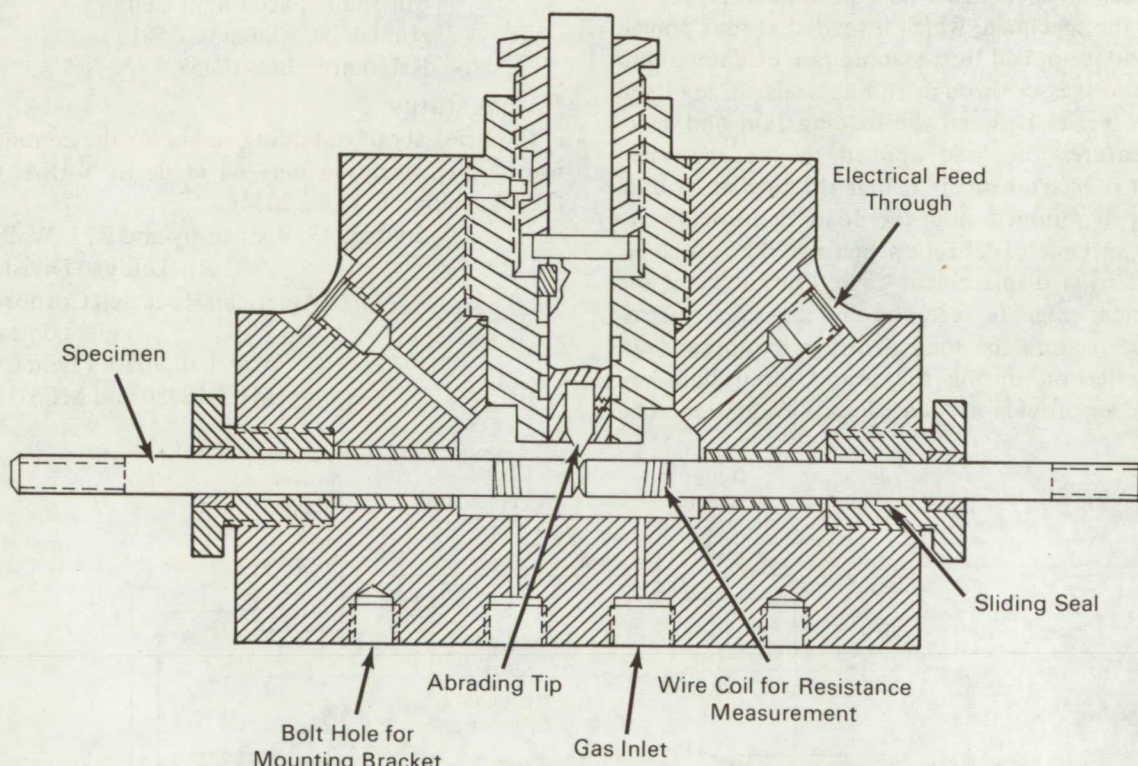


Fig. 1. Device for Abrading Tensile Specimens in High-Pressure Hydrogen

The problem:

Design and construct apparatus for abrasion and fracture testing of materials evaluated for storage of hydrogen at high pressures for long periods.

The solution:

Two necessary devices were developed. Figure 1 is a schematic of a device for abrading tensile specimens in high-pressure hydrogen. This device also permits the electrical resistivity of the specimen to be

measured while abrasion or tensile testing of the specimen is in progress. Figure 2 (overleaf) is a schematic of a device for fracture toughness testing of metals in high-pressure hydrogen. Both devices permit testing in both yield and failure modes.

How it's done:

The apparatus shown in Figure 1 is used for abrading the surface of cylindrical specimens in hydrogen at pressures up to 15,000 psi. While its surface is

(continued overleaf)

being abraded, the specimen can be held under tensile load and tensile tested to failure.

Electrical isolation between the specimen and the vessel and penetration of the electrical wires through the vessel wall permit measurement of the electrical resistivity of the specimen while being abraded or tensile tested. The abrader has an interchangeable tip so that a strip approximately 1/4 inch wide can be abraded on unnotched specimens, or so that the root of a notch (0.001-inch notch radius) can be scratched.

The apparatus shown in Figure 2 is used for bend testing fairly large (2.5 inch thick by 1.25 inch wide by 14 inches long) rectangular specimens in hydrogen at pressures up to 15,000 psi. Normal, notched, or precracked specimens can be tested. A fixture supports the specimen, which is loaded at four points.

The load is applied by a loading ram extending into the pressure vessel through sliding seals. A load cell inside the vessel between the loading ram and specimen measures the load applied to the specimen. This ram is instrumented so that the rate of loading can be programmed and the load continually recorded. Specimen deflection across the notch is measured by a displacement gage. Output from the displacement gage is recorded by the same instrument that records the load in order to obtain load versus deflection during the test. Output data are integrated to provide a "quick-look" evaluation. The

inclusion of sensing elements of high criticality in the test atmosphere eliminates several high-pressure sealing problems and substantially improves the level of confidence in the data obtained.

Notes:

1. Abrasion and fracture testing can be carried out in gases other than hydrogen.
2. Metallurgical and materials testing laboratories, research and development facilities, and manufacturers of cryogenic equipment and high-pressure storage vessels may be interested in these techniques.
3. No further documentation is available. Inquiries may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B69-10457

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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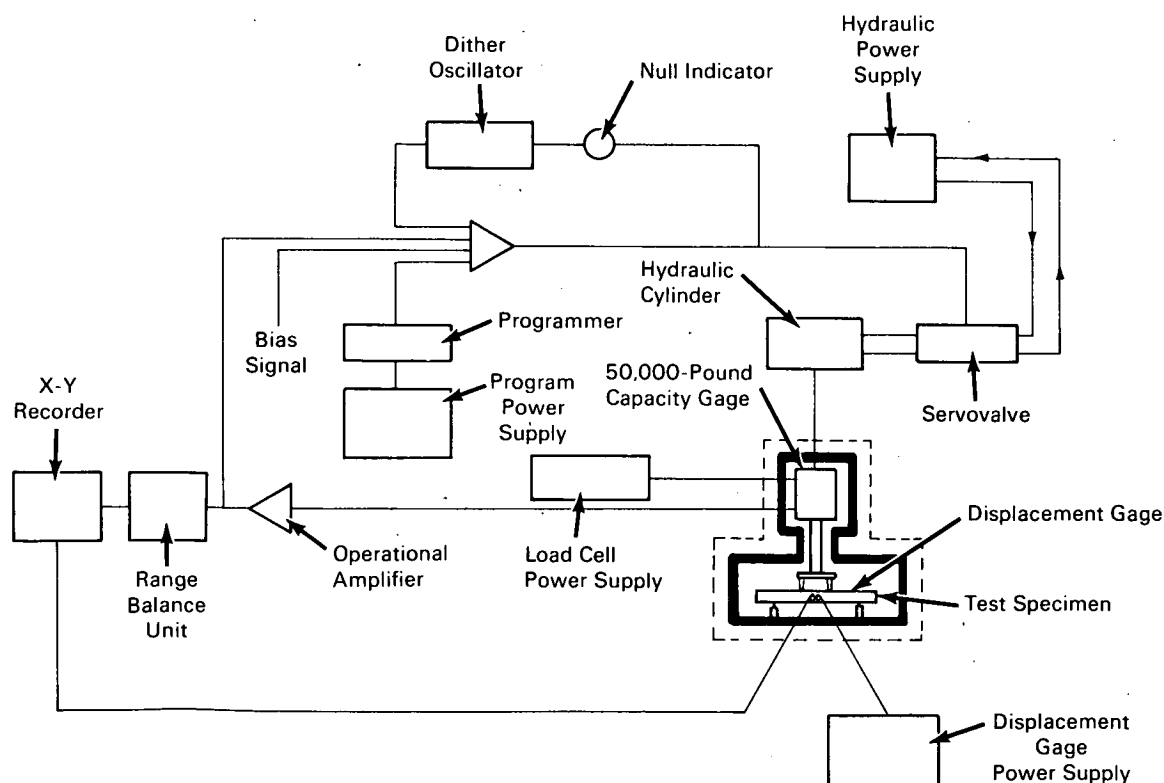


Fig. 2. Fracture Toughness Testing in High-Pressure Hydrogen